

## **REGULATION III - CONTROL OF AIR CONTAMINANTS**

### **RULE 324**

## **STATIONARY INTERNAL COMBUSTION (IC) ENGINES**

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**MARICOPA COUNTY**  
**AIR POLLUTION CONTROL REGULATIONS**  
**REGULATION III - CONTROL OF AIR CONTAMINANTS**  
**RULE 324**  
**STATIONARY INTERNAL COMBUSTION (IC) ENGINES**

**SECTION 100 – GENERAL**

**101 PURPOSE:** To limit carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), sulfur oxides (SO<sub>x</sub>), volatile organic compounds (VOCs), and particulate matter (PM) emissions from stationary internal combustion (IC) engines, including stationary IC engines used in cogeneration.

**102 APPLICABILITY:** The provisions of this rule apply to any single existing or new stationary spark or compression-ignited reciprocating IC engine or IC engine used in cogeneration with a rating of greater than 250 brake horsepower (bhp). The provisions of this rule also apply to a combination of IC engines each with a rated brake horsepower greater than 50 bhp used at a single source, whose maximum aggregate rated brake horsepower is greater than 250 bhp.

**103 EXEMPTIONS:** The following types of stationary IC engines are exempt from all of the requirements of this rule but shall comply with Rule 300:

**103.1** Any rotary engine, including gas turbines, jet engines,

**103.2** An IC engine operated as a non-road engine,

**103.3** An IC engine used directly and exclusively by the owner and/or operator for agricultural operations necessary for the growing of crops or the raising of fowl or animals,

**103.4** A laboratory IC engine used directly and exclusively for engine research including engine development, and subsequent engine performance verification for the purpose of either engine emission control techniques or engine efficiency improvements,

**103.5** A prime engine when it is operated for purposes of performance verification and testing by the owner or operator or by a manufacturer or distributor of such equipment for the purpose of performance verification and testing at the production facility,

**103.6** A compressed gas IC engine used for solar testing and research programs,

**103.7** An IC engine operated as an emergency generator or other equipment at a nuclear power plant that must run for safety reasons and/or operational tests to meet requirements imposed by the Nuclear Regulatory Commission,

**103.8** An IC engine test stand used for evaluating engine performance, and

**103.9** An IC engine used for training purposes as long as the total number of hours of the operation does not exceed 100 hours per calendar year per engine.

**104 PARTIAL EXEMPTIONS FOR EMERGENCY ENGINES:** Any stationary IC engine operated as an emergency engine for any of the following reasons is exempt from all of the provisions of this rule, except for the provisions in Sections 301, 303, and subsections 502.1 and 502.4:

**104.1** Used only for power when normal power service fails from the serving utility or if onsite electrical transmission or onsite power generation equipment fails;

**104.2** Used only for the emergency pumping of water resulting from a flood, fire, lightning strikes, police action or for any other essential public services which affect the public health and safety;

**104.3** Used for lighting airport runways;

**104.4** Used for sewage overflow mitigation and/or prevention;

**104.5** Used for reliability-related activities such as engine readiness, calibration, or maintenance or to prevent the occurrence of an unsafe condition during electrical system maintenance, as long as the total number of hours of the operation does not exceed 100 hours per calendar year per engine;

**104.6** Used as the prime engine when the prime engine has failed, but only for such time as is needed to repair the prime engine; or

**104.7** Used to operate standby emergency water pumps for fire control that activate when sensors detect low water pressure.

**105 PARTIAL EXEMPTIONS FOR NON-EMERGENCY LOW USAGE PRIME ENGINES:** The following non-emergency, low usage, prime engines are exempt from all of the provisions of this rule except for the provisions in Sections 301, 303 and subsections 502.1 and 502.4:

**105.1** Each engine rated at or below 1000 bhp that operates less than 200 hours in any 12-consecutive-month period, and

**105.2** Each engine rated above 1000 bhp that operates less than 100 hours in any 12-consecutive month period.

**SECTION 200 – DEFINITIONS:** For the purpose of this rule, the following definitions shall apply. See Rule 100 (General Provisions And Definitions) of these rules for definitions of terms that are used but not specifically defined in this rule.

- 201 AFTERCOOLER / INTERCOOLER**– A system that cools the engine intake air or air/fuel mixture after the air exits the turbocharger and prior to the introduction into the cylinder, thereby lowering NOx emissions.
- 202 COGENERATION UNIT**– Internal combustion engine unit that burns fuel to simultaneously produce electricity and heat in a single thermodynamic process and is usually located in close proximity to the equipment requiring the heat energy.
- 203 COMPRESSION - IGNITION ENGINE** – A reciprocating internal combustion engine with operating characteristics wherein the principal mechanism of igniting the fuel and air mixture in the cylinders is the compression of air in the cylinder until it is so hot that any fuel injected into the air or mixed with the air ignites. In this type of engine, a separate ignition source, such as a spark plug, is not used.
- 204 DIESEL ENGINE** – A type of compression- ignited IC engine.
- 205 EMERGENCY ENGINE**– Any stationary standby IC engine whose sole function is to provide back-up power when electric power from the local utility is interrupted or when operated solely for any of the reasons listed in Section 104. An emergency engine, for the purposes of this rule, shall not be used to supply standby power due to a voluntary reduction in power by a utility or power company, supply power for distribution or sale to the

grid, or supply power at a source in order to avoid peak demand charges or high electric energy prices during on-peak price periods.

**206 ENGINE FAMILY** - A group of engines with similar design features such as fuel type, cooling medium, method of air aspiration, combustion chamber design including cylinder bore and stroke, exhaust aftertreatment (if any), method of fuel admission, and method of control. These engines are also expected to have similar emission and operating characteristics throughout their useful lives.

**207 EQUIVALENT REPLACEMENT ENGINE** - An engine that is substituted for a stationary IC engine that is intended to perform the same or similar function as the original engine and where all of the following conditions exist:

**207.1** The replacement engine results in equal or lower air contaminant emissions than the existing engine;

**207.2** The replacement engine meets the emission control technology standards contained in either Table 1 or Table 2 of this rule, and

**207.3** The rated bhp of the replacement engine does not exceed the rated bhp of the existing engine (or sum of existing engines) by more than 20 percent.

**208 EXISTING ENGINE** - An engine that commenced operation prior to October 22, 2003 or an engine on which the construction or modification has commenced prior to October 22, 2003, including the contractual obligation to undertake and complete an order for an engine.

**209 IDENTICAL REPLACEMENT ENGINE** -An engine that is substituted for an existing stationary IC engine that has the same manufacturer type, model number, manufacturer's maximum rated capacity, bhp, and that is intended to perform the same or similar function as the original stationary IC engine that it replaces and has equal or lower emissions or meets the emission control technology requirements in Section 304, Table 1, 2, or 3.

**210 INTERNAL COMBUSTION (IC) ENGINE, NONROAD**

**210.1** Any IC engine:

**a.** In or on a piece of equipment that is self-propelled or serves a dual purpose by both propelling itself and performing another function (such as garden tractors, off-highway mobile cranes and bulldozers);

**b.** In or on a piece of equipment that is intended to be propelled while performing its function (such as lawnmowers and string trimmers); or

**c.** That, by itself or in or on a piece of equipment, is portable or transportable, meaning designed to be and capable of being carried or moved from one location to another. Indicia of transportability include but are not limited to, wheels, skids, carrying handles, dollies, trailers, or platforms.

**210.2** An internal combustion engine is not a nonroad engine if:

**a.** The engine is used to propel a motor vehicle or a vehicle used solely for competition, or is subject to standards promulgated under Section 202 of the Clean Air Act;

**b.** The engine is regulated by a federal New Source Performance Standard promulgated under Section 111 of the Clean Air Act;



c. The engine otherwise included in paragraph (c) above of this definition remains or will remain at a location for more than 12 consecutive months or a shorter period of time for an engine located at a seasonal source. A location is any single site at a building, structure, facility, or installation. Any engine (or engines) that replaces an engine at a location and that is intended to perform the same or similar function as the engine replaced will be included in calculating the consecutive time period. An engine located at a seasonal source is an engine that remains at a seasonal source during the full annual operating period of the seasonal source. A seasonal source is a stationary source that remains in a single location on a permanent basis (i.e. at least two years) and that operates at that single location approximately three months (or more) each year. This paragraph does not apply to an engine after the engine is removed from the location.

**211 INTERNAL COMBUSTION (IC) ENGINE, STATIONARY** - Any reciprocating, piston-driven IC engine that is operated or intended to be operated at one specific location for more than 12 consecutive months or that is attached to a foundation at the location. Any engine that replaces an engine at a location and is intended to perform the same or similar function as the engine being replaced will be included in calculating the consecutive time period. A stationary IC engine is not a non-road engine.

**212 LEAN-BURN ENGINE** – A spark-ignited engine with an air-to-fuel operating range that has more air present than is needed to burn the fuel present and cannot be adjusted to operate with an exhaust oxygen concentration of less than or equal to 2 %.

**213 LOCATION** – Any single site at a building, structure, facility or installation.

- 214 LOW SULFUR OIL** – Fuel oil containing less than or equal to 0.05 % sulfur by weight.
- 215 NEW ENGINE** -An engine that is not an existing engine.
- 216 NITROGEN OXIDES (NO<sub>x</sub>)** – Oxides of nitrogen calculated as equivalent nitrogen dioxide.
- 217 PART(S) PER MILLION, DRY VOLUME (ppmdv)** – A unit of proportion equal to 10<sup>-6</sup> that is measured on a dry basis (minus water) at 15% oxygen.
- 218 PRIME ENGINE** – A principal or main use engine that is dedicated to a process or processes for the purpose of supplying primary mechanical or electrical power as opposed to an emergency engine.
- 219 RATED BRAKE HORSEPOWER** - The maximum brake horsepower (bhp) specified by the engine manufacturer for the engine application, usually listed on the nameplate of the engine. If the engine has been altered so that the maximum brake horsepower is different than the rated brake horsepower on the nameplate, then the maximum brake horsepower shall be considered the rated brake horsepower.
- 220 RICH-BURN ENGINE** - Any spark-ignited IC engine that is not a lean-burn engine.
- 221 SPARK-IGNITION ENGINE** – An IC engine wherein the fuel is usually mixed with intake air before introduction into the combustion chamber resulting in a relatively homogeneous air/fuel mixture in the combustion chamber, at which time a spark plug then ignites the air/fuel mixture.
- 222 SULFUR OXIDES (SO<sub>x</sub>)** – Oxides of sulfur calculated as equivalent sulfur dioxide.

**223 WASTE DERIVED FUEL GAS** - Any gaseous fuel that is generated from the biodegradation of solid or liquid waste including, but not limited to, sewage sludge, digester gas, and landfill gas.

**SECTION 300 – STANDARDS:**

**301 LIMITATIONS FOR NEW AND EXISTING STATIONARY IC ENGINES:** An owner or operator of any engine that meets the criteria listed in Section 102 shall comply with the following:

**301.1** Use any fuel that contains no more than 0.05% sulfur by weight, alone or in combination with other fuels, with the following exception: Existing supplies in storage as of October 23, 2003 of any fuel containing greater than 0.05% of sulfur by weight may be used by the owner or operator until April 22, 2005. This usage shall be reported to the Control Officer along with the dates of usage.

**301.2** Obtain prior approval from the Control Officer as a provision in individual permits when using any waste derived fuel gas that contains sulfur in a concentration greater than 0.05% sulfur by weight.

**302 GOOD COMBUSTION PRACTICES / TUNING PROCEDURE:** An owner or operator shall conduct preventative maintenance or tuning procedures recommended by the engine manufacturer to ensure good combustion practices to minimize NO<sub>x</sub> emissions. A handheld monitor may be used if so desired by the owner or operator for measurement of NO<sub>x</sub>, CO, and concentrations in the effluent stream after each adjustment is made. This may assist in determining that the proper adjustment has been made to ensure NO<sub>x</sub> and CO minimization. In lieu of a manufacturer's procedure, a different procedure specified by any other maintenance guideline may be used as a default procedure. The tuning procedure shall include all of the following, if so equipped, and appropriate to the type of engine.

**302.1** Lubricating Oil and Filter: change once every three months or after no more than 300 hours of operation, whichever occurs last;

**302.2** Inlet Air Filter: clean once every three months or after no more than 300 hours of operation and replace every 1,000 hours of operation or every year, whichever occurs last;

**302.3** Fuel Filter: clean once every year or replace (if cartridge type) once every 1,000 hours of operation, whichever occurs last;

**302.4** Check and adjust the following once every year or after no more than 1,000 hours of operation, whichever occurs last:

- a. intake and exhaust valves
- b. spark plugs (if so equipped)
- c. spark timing and dwell or fuel injection timing (if adjustable), and
- d. carburetor mixture (if adjustable).

**302.5** Spark Plugs and Ignition Points: replace after 3,000 hours of operation or every year whichever occurs last;

**302.6** Coolant: change after 3,000 hours of operation or every year whichever occurs last; and

**302.7** Exhaust System: check for leaks and/or restrictions after 3,000 hours of operation or every year whichever occurs last.

**303 LIMITATIONS – OPACITY:** No owner or operator shall discharge into the ambient air from any single source of emissions any air contaminant, other than uncombined water, in excess of 20% opacity.

**304 ADDITIONAL LIMITATIONS FOR PRIME ENGINES > 250 RATED bhp:** In addition to meeting the standards in Sections 301, 302, and 303, each existing or new prime engine greater than 250 rated bhp that is not listed in Sections 103, 104, or 105, shall comply with the emission limits or control technology requirements listed in Section 304, Table 1, 2, or 3, dependent upon the type of engine.

**NO<sub>x</sub> EMISSION LIMITS OR CONTROL TECHNOLOGY REQUIREMENTS FOR  
EXISTING COMPRESSION-IGNITION ENGINES > 250 bhp**

**TABLE 1**

<b>RATED BRAKE HORSEPOWER (bhp)</b>	<b>ENGINE REQUIREMENTS</b>
250-399	770 ppmdv or 10 g/bhp-hr.NO <sub>x</sub> or turbocharger with aftercooler/intercooler or 4-degree injection timing retard
400 plus	550 ppmdv or 7.2 g/bhp-hr.NO <sub>x</sub> or turbocharger with aftercooler/intercooler or 4-degree injection timing retard

**EMISSION LIMITS OR CONTROL TECHNOLOGY REQUIREMENTS FOR  
EXISTING APPLICABLE SPARK- IGNITION ENGINES > 250 RATED bhp**

**TABLE 2**

<b>OXIDES OF NITROGEN (NO<sub>x</sub>)</b>	<b>VOLATILE ORGANIC COMPOUND (VOC)</b>	<b>CARBON MONOXIDE (CO)</b>
280 ppmdv or 4.0 b/bhp-hr or three-way catalyst*	800 ppmdv or 5.0 g/bhp-hr or three-way catalyst*	4,500 ppmdv or three-way catalyst*

\* The three-way catalyst shall provide a minimum of 80% control efficiency for NO<sub>x</sub> and CO for those engines fueled with natural gas, propane or gasoline. In addition the three-way catalyst shall also provide a minimum of at least 50% control efficiency for VOC for those engines fueled by gasoline.

**EMISSION LIMITS FOR NEW SPARK OR COMPRESSION-IGNITION ENGINES >****250 bhp****TABLE 3**

<b>ENGINE TYPE</b>	<b>NO<sub>x</sub></b>	<b>PM</b>	<b>CO</b>
LEAN BURN (SPARK)	110 ppm <sub>dv</sub> or 1.5 g/bhp-hr.	Not Applicable	4,500 ppm <sub>dv</sub>
RICH BURN (SPARK)	20 ppm <sub>dv</sub> or 0.30 g/bhp-hr.	Not Applicable	4,500 ppm <sub>dv</sub>
COMPRESSION	530 ppm <sub>dv</sub> or 6.9 g/bhp-hr.	0.40 g/bhp-hr	1,000 ppm <sub>dv</sub>

**305 EFFICIENCY ALLOWANCE**

Each emission limit expressed in Tables 1, 2 or 3 may be multiplied by X, where X equals the engine efficiency (E) divided by a reference efficiency of 30 percent. Engine efficiency shall be determined by one of the following methods whichever is higher:

**a**  $E = (\text{Engine Output}) \times (100) \div (\text{Energy Input})$

where energy input is determined by a fuel measuring device accurate to +/- 5 % and is based upon the higher heating value (HHV) of the fuel. Percent efficiency (E) shall be averaged over 15 consecutive minutes and measured at peak load for the applicable engine.

**b.**  $E = (\text{Manufacturers Rated Efficiency [Continuous] at LHV}) \times (\text{LHV}) \div (\text{HHV})$

where LHV = the lower heating value of the fuel

Engine efficiency (E) shall not be less than 30 percent; an engine with an efficiency lower than 30 percent shall be assigned an efficiency of 30 percent for the purposes of this rule.

- 306 EQUIVALENT OR IDENTICAL ENGINE REPLACEMENT:** An equivalent or identical replacement engine that replaces an existing engine shall be treated as an existing engine for the purposes of compliance with this rule, unless the engine commenced operation or was constructed or modified after October 22, 2003, including the contractual obligation to undertake and complete an order for an engine and then it will be considered a new engine for purposes of meeting the standards for a new engine in this rule.

## **SECTION 400 - ADMINISTRATIVE REQUIREMENTS**

### **401 COMPLIANCE SCHEDULE:**

- 401.1** An owner or operator of an existing or new stationary IC engine that becomes subject to any of the emission limits listed in Section 300 of this rule and that does not need modification or add-on controls to meet these emission standards shall be in compliance by April 22, 2004.
- 401.2** An owner or operator of an existing stationary IC engine that must be rebuilt, modified, or retrofitted with add-on control equipment to meet emission limits listed in Section 300 of this rule shall submit a compliance plan for such unit by October 22, 2004 and shall be operating in full compliance by October 22, 2006.
- 401.3** An owner or operator of an existing stationary IC engine that must be replaced with a new engine to meet emission limits listed in Section 300 and shall be in compliance with the emission limits listed in Section 304 Table 3 by October 22, 2007.

## **SECTION 500 - MONITORING AND RECORDS**

### **501 COMPLIANCE DETERMINATION:**

**501.1 Existing Engines:** Existing IC engines or engine families shall demonstrate compliance with Section 300 by recordkeeping according to Section 502. Emission testing using the applicable test methods listed in Section 503 shall be performed if the Control Officer requests.

**501.2 Existing Engine Families at a Source:** When testing an engine family at one source, the number of engines tested should be the greater of either one engine or one third of all identical engines in the group. If any of the representative engines exceed the emission limits, each engine in the group shall demonstrate compliance by emissions testing.

**501.3 New Engines / New Engine Families:** Compliance with the limitations listed in Section 304, Table 3 shall be demonstrated by either:

- a.** A statement from the manufacturer that the engine meets the most stringent emissions standards found in 40 CFR Part 89 or 90 applicable to the engine and its model year at the time of manufacture or
- b.** Performance of emission testing using the test methods listed in Section 503.

**501.4 Low Sulfur Oil Verification:** If the Control Officer requests proof of the sulfur content, the owner or operator shall submit



fuel receipts, contract specifications, pipeline meter tickets, Material Safety Data Sheets (MSDS), fuel supplier information or purchase records, if applicable, from the fuel supplier, indicating the sulfur content of the fuel oil. In lieu of these, testing of the fuel oil for sulfur content to meet the 0.05% limit shall be permitted if so desired by the owner or operator for evidence of compliance.

**501.5 Waste - Derived Fuel Sulfur Verification:** The owner or operator shall submit documentation of the concentration of the sulfur level of the waste derived fuel to the Control Officer.

**501.6 Test Method Conditions:** The owner or operator shall use the test methods listed in Section 503 to determine compliance with the limitations in Section 304, Tables 1-3. Testing for stationary IC engines shall be completed under steady state conditions at either the maximum operating load or no less than 80% of the rated brake horsepower rating. If the owner or operator of an engine demonstrates to the Control Officer that the engine cannot operate at these conditions, then emissions source testing shall be performed at the highest achievable continuous brake horsepower rating or under the typical duty cycle or typical operational mode of the engine.

**502 RECORDKEEPING / RECORDS RETENTION:** The owner or operator of any stationary IC engine subject to this rule shall comply with the following requirements and keep records for a period of 5 years:

**502.1** An owner or operator of any IC engine, including emergency engines, prime engines and low usage engines, shall keep a record that includes an initial one time entry that lists the particular engine combustion type (compression or spark-ignition or rich or lean

burn); manufacturer; model designation, rated brake horsepower, serial number and where the engine is located on the site.

**502.2** An owner or operator of a prime engine shall maintain a monthly record for prime engines which shall include:

1. Hours of operation;
2. Type of fuel used, and
3. Documentation verifying compliance with sulfur fuel content according to Section 103.

**502.3** An owner or operator of a prime engine shall maintain an annual record of good combustion procedures according to Section 302.

**502.4** An owner or operator of an emergency engine and a non-emergency low-usage engine that meets the exemptions listed in Sections 104 and 105 shall keep an annual engine record that includes:

1. Hours of operation; and
2. Explanation for the use of the engine if it is used as an emergency engine.

**503 TEST METHODS:** The Environmental Protection Agency (EPA) test methods as they exist in the Code of Federal Regulations (CFR) (July 1, 2002), as listed below, are adopted by reference. The American Society of Testing Materials International (ASTM International) methods listed below are also adopted by reference, each having paired with it a specific date(s) that identifies the particular version/revision of the method that is adopted by reference. These adoptions by reference include no future editions or amendments. When more than one test method is permitted for the same determination, as listed in subsections 503.11, 503.12, 503.13, or 503.14, an exceedance of the limits established in this rule determined by any of the applicable test methods constitutes a violation. Copies of test methods

referenced in this section of this rule are available at the Maricopa County Environmental Services Department, 1001 North Central Avenue, Suite 201, Phoenix, Arizona, 85004 -1942.

**503.1** EPA Reference Methods 1 ("Sample and Velocity Traverses for Stationary Sources") and 1A ("Sample and Velocity Traverses for Stationary Sources with Small Stacks and Ducts") (40 CFR 60, Appendix A).

**503.2** EPA Reference Methods 2 ("Determination of Stack Gas Velocity and Volumetric Flow Rate"), 2A ("Direct Measurement of Gas Volume Through Pipes and Small Ducts"), 2C ("Determination of Stack Gas Velocity and Volumetric Flow Rate in Small Stacks or Ducts"), and 2D ("Measurement of Gas Volumetric Flow Rates in Small Pipes and Ducts") (40 CFR 60, Appendix A).

**503.3** EPA Reference Methods 3 ("Gas Analysis for the Determination of Dry Molecular Weight"), 3A ("Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)", 3B ("Gas Analysis for the Determination of Emission Rate Correction Factor of Excess Air"), and 3C ("Determination of Carbon Dioxide, Methane, Nitrogen and Oxygen from Stationary Sources") (40 CFR 60, Appendix A).

**503.4** EPA Reference Method 4 ("Determination of Moisture Content in Stack Gases") (40 CFR 60, Appendix A).

**503.5** EPA Reference Method 5 ("Determination of Particulate Emissions from Stationary Sources") (40 CFR 60, Appendix A) and possibly, if requested by the Control Officer, EPA Reference Method 202

("Determination of Condensable Particulate Emissions from Stationary Sources") (40 CFR 51, Appendix M).

**503.6** Emissions from Stationary Sources"), 7A ("Determination of Nitrogen Oxide Emissions from Stationary Sources - Ion chromatographic method"), 7B ("Determination of Nitrogen Oxide Emissions from Stationary Sources – Ultraviolet Spectrometry"), 7C ("Determination of Nitrogen Oxide Emissions from Stationary Sources – Alkaline-Permanganate Colorimetric Method"), 7D ("Determination of Nitrogen Oxide Emissions from Stationary Sources – Alkaline – Permanganate Chromatographic Method"), and 7E ("Determination of Nitrogen Oxide Emissions from Stationary Sources – Instrumental Analyzer Method"), (40 CFR 60, Appendix A).

**503.7** EPA Reference Method 9 ("Visual Determination of the Opacity of Emissions from Stationary Sources") (40 CFR 60, Appendix A).

**503.8** EPA Reference Method 10 ("Determination of Carbon Monoxide from Stationary Sources") (40 CFR 60, Appendix A).

**503.9** EPA Reference Method 18 ("Measurement of Gaseous Organic Compound Emissions by Gas Chromatography") (40 CFR 60, Appendix A).

**503.10** EPA Reference Method 25A ("Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer") (40 CFR 60, Appendix A).

**503.11** American Society of Testing Materials International, ASTM Method #D1266-98 ("Standard Test Method for Sulfur in Petroleum Products (Lamp Method)"), 1998.

**503.12** American Society of Testing Materials International, ASTM Method #D2622-98 ("Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-Ray Fluorescence Spectrometry"), 1998.

**503.13** American Society of Testing Materials International, ASTM Method #D2880-71, 78 or 96 ("Standard Specification for Gas Turbine Fuel Oils"), 1971 or 1978 or 1996.

**503.14** American Society of Testing Materials International, ASTM Method #D4294-98 ("Standard Test Method for Sulfur in Petroleum Products by Energy-Dispersive X-Ray Fluorescence Spectroscopy") 1990 or 1998.